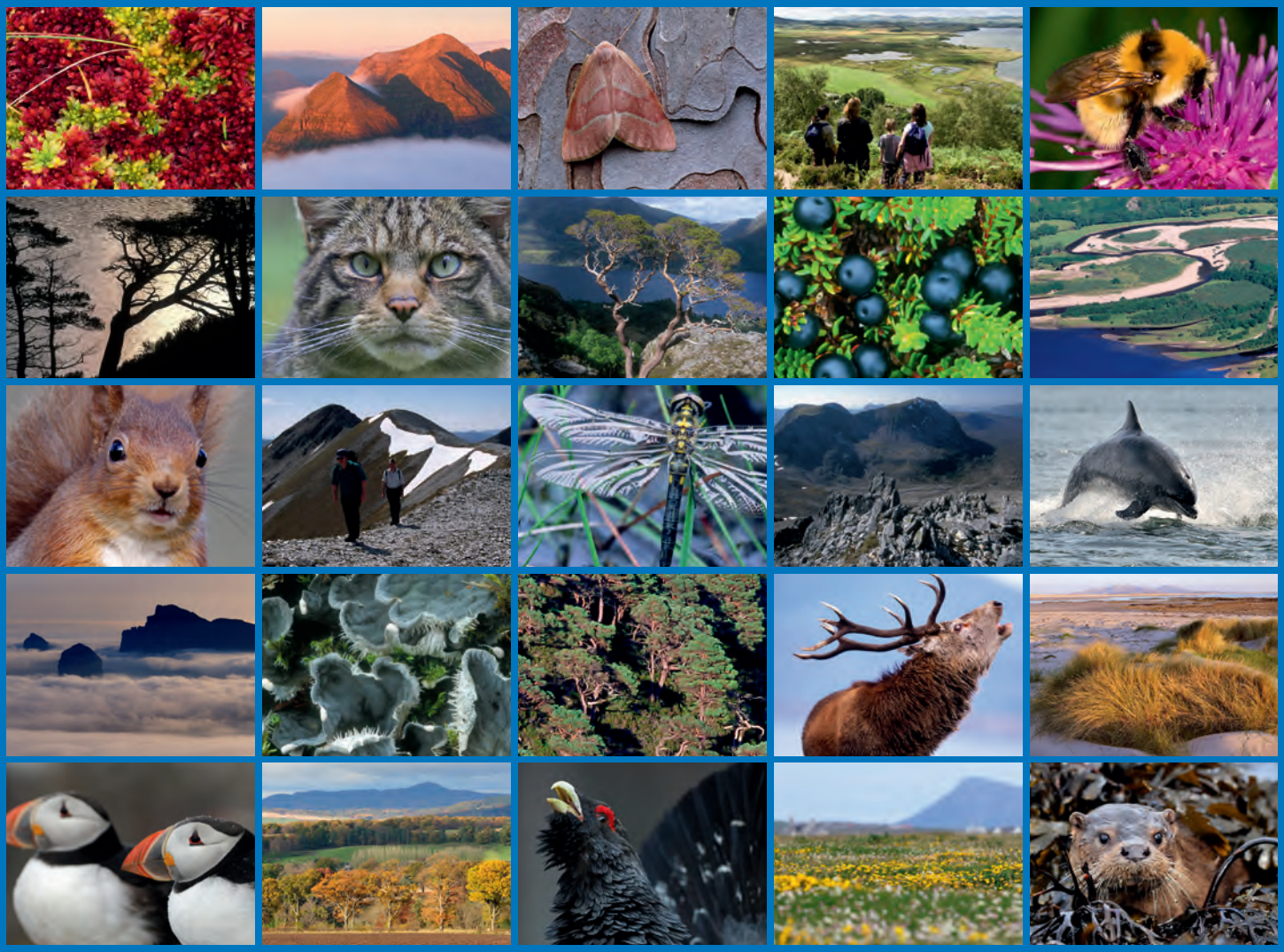
Scottish Natural Heritage
Commissioned Report No. 719

Investigation of Standing Water and Wetland SSSIs thought to be under Diffuse Pollution Pressure: Clarilaw Grasslands



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COMMISSIONED REPORT

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Investigation of Standing Water and Wetland SSSIs thought to be under Diffuse Pollution Pressure: Clarilaw Grasslands

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COMMISSIONED REPORT

Summary

Investigation of Standing Water and Wetland SSSIs thought to be under Diffuse Pollution Pressure: Clarilaw Grasslands

Commissioned Report No. 719
Project No: 13700
Contractor: EnviroCentre Ltd.
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Keywords

Diffuse pollution; SSSIs; wetland; water; soil; samples; recommendation.

Background

SNH contracted EnviroCentre to look at a number of Sites of Special Scientific Interest across Scotland thought to be adversely affected by diffuse pollution. EnviroCentre was asked to carry out a number of tasks to help SNH understand better whether sites are being affected by diffuse pollution and if so, what activities might be contributing to this pressure and how SNH could improve the condition of the sites.

If sites are identified as being affected by diffuse pollution, SNH hope that the results of this report will inform their work with managers of the sites to improve their conditions.

Main findings

- The desk study and site walkover identified potential existing and historical land use practices within the catchment that could adversely affect water quality and soil nutrient status. This included long-term changes resulting from diffuse agricultural sources and land use management practices within the catchment.
- Analytical data confirmed the presence of elevated nutrients but given the size of the site relative to the pre-determined sample locations, this may not be representative of the site as a whole. It should further be noted that the sampling assessment was undertaken as a single visit and the limited scoped dataset and a lack of historical data constrains the ability to draw accurate conclusions to fully inform current site conditions.
- A series of recommendations are proposed to seek to aid the understanding of the site and afford a greater insight into the perceived changes taking place within the SSSI.

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Acknowledgements

EnviroCentre Ltd would like to thank the SNH Operations staff for their time and assistance in providing access to the site files held at the local office, providing landowner contact details, and in aiding the preliminary understanding of the site to assist with the health and safety evaluation prior to the initial visit.

Thanks are also extended to the site landowners for affording access to the site to enable the agreed scope of work to be undertaken.

1. INTRODUCTION

EnviroCentre Ltd was contracted by Scottish Natural Heritage (SNH) in August 2012 to deliver the 'Investigation of Standing Water and Wetland SSSIs under diffuse pollution pressure' project. The data collected from the project will be used to inform management decisions on wetland and standing water Sites of Special Scientific Interest (SSSI).

1.1 Site Location

Clarilaw Grasslands is situated approximately 5 kilometres (3 miles) north east of Hawick and immediately east of the village of Clarilaw. The site is accessible off the B6359 with vehicle access to the site possible via track access to the northern and western boundaries. See Figure 1.1 in Annex 1.

1.2 Site Description

Clarilaw Grasslands is a SSSI designated for calcareous grassland, a basin fen and for the aquatic water beetle assemblage present in the fen. The site comprises an area of 44.01 hectares (SNH, 2011a), with an elevation of 240m AOD and has been designated since 1978.

The site has two component parts. The lowland calcareous grassland interest of the SSSI is found in the western section of the site, approximately 1.5 kilometres (1 mile) west of Clarilaw Farm and has not been included for the purposes of this study. The basin mire and beetle interest of the SSSI are found in the eastern part of the site which has comprised the focus of this study.

The eastern part of the site comprises a dry ridge of unimproved grassland at Camp Knowe and Blackchester Moss, a small basin mire. Surrounding the margins of the mire are areas of damp grassland which support some higher plant species that are again uncommon in the Borders. Although there is a small area of species-rich grassland present in this section there are also areas of improved and semi-improved grassland which make the overall grassland nature conservation interest lower than that of the western section (SNH, 2011c). The southern field is currently grazed by cattle, with a well-marked track running east from Clarilaw Farm. It also has a trig point and an ancient fort. The northern field is used for silage and is grazed by sheep. A small spring emerges in the centre of the field. Both fields have very small exposed outcrops of rock along the steep ridges. Fencing has been erected along the north side of the western arm of Blackchester Moss which is presumed to define the SSSI boundary. The southern boundary of the site borders an unnamed expanse of open water which is understood to be used for fishing.

In July 2010, 11 species of aquatic beetle were recorded at the site. This is understood to be less than that previously observed in 1975 and it is stated that the assemblage should no longer be considered a Qualifying Feature (SNH, 2011b). This is contradicted in the SNH Site Management Statement (SNH, 2011c) where 30 species are recorded as being present.

The underlying solid geology at the site consists of sedimentary wackes from the Hawick Group (British Geological Survey,n.d). The grassland slopes are free draining, shallow and prone to drought. This combination leads to species-rich calcareous grasslands, which are now very uncommon in the Borders.

1.3 Site Hydrology

There are no watercourses within the site and a catchment watershed divides the site.

The northern part of the site is located in the upper catchment of St. Boswells Burn, which is located to the north-east of the site, while the southern part of the site is located in the Ale Water catchment. The standing water (Blackchester Moss) in the western part of the site is believed to be derived from surface runoff with possible contribution from a spring feed from the centre of the site. There is the potential that the wider site is also fed by springs but none are noted on corresponding mapping or recorded in the desk study records. It is anecdotally recorded that the south western part of the site is waterlogged for long periods. The catchment area contributing surface water runoff to the site is not much larger than the area of the site itself, at 0.44km^2. The annual average rainfall for this site is 726mm (Centre for Ecology and Hydrology, 2009).

A small unnamed open waterbody is located directly adjacent to the southern boundary of the site. This is understood to be eutrophic and is operated as a private fishery.

1.4 Site History

Limited records of the site were available to inform the project. A library search was carried out to determine whether there was historical information available to aid this report. Aside from ancient monument and archaeological information on Blackchester Fort and settlement – a pre-historic ridge fort dating from the Iron Age – an internet search did not reveal any additional relevant information on the site.

Unreferenced SNH file records state that fertiliser applications were a frequent occurrence pre-1980 with these being concentrated on the south and western aspects of the site.

1.5 Recent Site Management Practices

The desk study revealed that from 1991-2012 a management agreement has been in place for the majority of the site. This was implemented to control the enrichment of the unimproved grassland by fertiliser application and dunging by livestock, the grazing levels and stock feeding practices.

It is understood that an SNH Natural Care Agreement (2007-2012) covers the rest of the site (SNH, 2011c). This document was not available to EnviroCentre.

Under both of these agreements scrub control is carried out, agricultural weeds (including thistles) and grazing numbers are all controlled.

There is also reference to aquatic vegetation being cut back in Blackchester Moss to maintain areas of open water for drinking water access to stock (SNH, 2011c).

It is also understood from SNH file records (Tabor, 1999) that the site has historically been subjected to applications of lime – limited to three tonnes per annum. The purpose of this is not confirmed in the reviewed documentation. No detailed record of these applications was available during the desk study review.

2. METHODOLOGY

The following sections outline the approach undertaken to fulfil the scope of works established by SNH in the Statement of Requirements (SOR).

2.1 Pre-site Attendance Desk Study

Before the initial site visit was undertaken the local SNH officer was contacted and a meeting held at the corresponding local office to discuss the local understanding of the site and review SNH records.

The meeting was also used to provide an insight into any health and safety constraints not readily apparent from the site maps.

Landowners of the site were notified of the planned site visit a week before the proposed visiting date. This allowed landowners the opportunity to ask any questions and also gave EnviroCentre staff a chance to gain a greater understanding to the workings of the site and the site surrounds. Landowner details are provided in Annex 2.

2.2 Site Attendance

The site was accessed and samples collected over a one day period – termed Visit 1. A follow up visit to the wider catchment was undertaken once the analytical data was available and appraised in context with the information obtained from the desk based exercise. Table 2.1 below shows site conditions on the day of each visit.

Table 2.1: Site Conditions

Clarilaw Grasslands	Date of Visit	Weather Conditions	Grid References
Visit 1	6 November 2012	Overcast, mild and occasional showers	NT 540277; NT 561274
Visit 2	12 March 2013	Cold, dull, dry	NT 540277; NT 5611274

2.3 Sampling Approach

SNH had determined the preferred locations for the collection of soil and water samples – as detailed in Figure 2.1 in Annex 1. EnviroCentre was not involved in determining these locations and had not assessed the suitability to access such before Visit 1. Due to certain access restrictions, the locations of samples that EnviroCentre collected had to be changed and are as detailed in Figure 2.2 in Annex 1. Changes to locations were kept to a minimum and are generally not deemed to have a significant impact on the sampling or conclusions.

All sampling methods were carried out by trained personnel. Photographs of each sampling location were taken (see Figure 2.3 in Annex 1) and grid references for each location recorded.

2.4 Sample Equipment

The following sample kit was used to undertake site field work:

- Handheld Global Positioning System (GPS) unit to record specific grid references;
- Handheld soil augers;
- Plastic bailers;
- Sample bottles (all sample bottles were written on to record locations, date and time); and

- Personal Protection Equipment (PPE - in line with the requirements of the site specific health & safety risk assessment).

All samples were given unique identification names and packaged in cool boxes with ice packs so as to keep samples at appropriate temperatures prior to being despatched to a United Kingdom Accreditation Service (UKAS) accredited laboratory for analysis.

2.5 Health and Safety

Site specific risk assessments were carried out before attending site. The assessment was based on information obtained from the meeting with the local officer and from EnviroCentre's extensive experience of undertaking previous work of this nature.

The risk assessment, which was completed by staff attending the site visit, included details of the landowner, nearest emergency services, and identified risks and proposed means of mitigation. Field operatives notified EnviroCentre head office when accessing and leaving site and wore the following appropriate PPE at all times:

- Warm and waterproof clothing;
- Waders;
- Waterproof footwear; and
- Hi-vis vest.

Biosecurity measures were rigorously implemented when entering and leaving site. Boots and equipment were washed when leaving site so as not to cross contaminate subsequent sites.

2.6 Water Samples

Surface water samples were collected from strategic locations within the site boundary to provide an understanding for the whole site. Due to limitations at this site, collections were made from standing (open) water only as no defined inflows or outflows were observed.

Groundwater samples were collected using plastic bailers from slotted pipes installed with hand augered holes where soil samples were originally collected. The sampling methodology employed a geosock membrane for coarse filtration so as to minimise samples being heavily loaded with suspended solids and organic material.

Samples underwent initial on-site field tests using an OTT Quanta Handheld probe for the following parameters:

- pH;
- Temperature;
- Electrical Conductivity (EC);
- Dissolved Oxygen (DO);
- Oxidation-Reduction Potential (ORP); and
- Salinity.

The water samples were submitted for the following analyses to a UKAS accredited laboratory:

- Total calcium (Ca), magnesium (Mg) and sodium (Na);
- N Species – total nitrogen, nitrate and ammonium;
- P Species – orthophosphate and total phosphorus; and
- Total iron (Fe).

Dissolved and ferrous iron analyses were scheduled in but could not be undertaken by the laboratory due to insufficient sample. This data would have supported interpretation of results if available but is not considered critical for determining the presence or potential sources of diffuse pollution.

2.7 Soil Samples

Soil samples were collected from specific locations on site by hand augering holes into the ground. The soil samples were collected at two depths:

- The rooting zone; and
- A depth of approximately one metre below the rooting zone.

  NB - In the corresponding results tables the samples are differentiated by the suffix 'A' for the rooting zone; and 'B' for below the rooting zone.

Soil samples were analysed for the following suite:

- Moisture content;
- Extractable nitrogen and phosphorus;
- Total nitrogen and phosphorus; and
- Total calcium (Ca); magnesium (Mg) and potassium (K).

Bulk density analysis was scheduled in but could not be undertaken by the laboratory due to insufficient sample. Total sodium (Na) and total organic carbon (TOC) were not scheduled in properly and analyses were not undertaken. The lack of this data is not considered to affect interpretation of results in terms of determining the presence and potential sources of diffuse pollution.

2.8 Field Observations

On accessing the site for the first visit, and the wider catchment for the second visit, the following field observations were noted:

- Geo-referenced photograph locations of surrounding land use (refer to Figure 2.4 in Annex 1);
- Adjacent land;
- Identified and potential pollution sources; and
- Atypical or unusual site features (*e.g.* fly tipping, vandalism, *etc.*).

In addition, mapping of the immediate surrounding catchment was completed following the second site visit (see Figure 2.5 in Annex 1). This process utilised the Flood Estimation Handbook (Centre for Ecology and Hydrology (CEH), 2009) catchments and Land Cover data (Land Cover Map 2007) to populate GIS mapping. The output was used to aid the interpretation of results and further inform the study conclusions.

3. STUDY LIMITATIONS

The scope of the commissioned study presented a series of limitations which should be borne in mind when reviewing this report. These are outlined below:

- It would appear from SNH records that the site comprises two separate areas of land. Only one of these areas, namely the eastern field on which Blackchester Fort stands, has been the subject of this scope of works. The other area which lies approximately 2km west of the study site (and is referred to as the western site) was not visited or appraised as part of this study.

- Sampling was undertaken on a single visit. Whilst this afforded consistency for the samples collected, the weather conditions preceding and at the time of the visit may have directly influenced the observations made and the analytical results obtained.

- For the same reasons outlined above, access to certain parts of the site may have been restricted and limited access to the predetermined sampling location.

- Sampling comprised a single set of samples from each of the pre-determined locations. Repeat or continuous sampling over an extended (seasonal) period would be preferred to enable a greater dataset to be collected. This would present a more representative assessment of the site and allow for seasonal/climatic variations.

- The dataset provides a 'snapshot' of the site condition. Due to the limited availability of historical data (see section 1.4) there is very limited scope for comparisons to be made with previous records or allowance for assessment of seasonal or climatic factors.

- The scope of work did not include the assessment of rainfall within the catchment, measure loch levels or the inflow(s)/outflow(s) of associated watercourses.

- The limited dataset does not allow for any statistical analysis of the results to be undertaken. No adjustment has been made for anomalous results or to determine trends over time.

- The sampling methodology used to obtain groundwater samples (obtained from a circa. 1m depth coupled with geosock membrane for coarse filtration) typically results in these samples being heavily loaded with suspended solids and organic material meaning that the samples appear 'dirty' to the naked eye. To avoid interference with the laboratory analytical instrumentation and erroneous results, on receipt at the laboratory these are processed on a x10 dilution. It is this dilution process which explains why some of the results are reported as a less than value rather than the equivalent level of detection of 'clean' samples. The same dilution approach is applied to heavy silted surface water samples.

- The weather conditions prior to and during the site visit should be taken into consideration when reviewing the results. According to the Met Office (n.d.) the seasonal rainfall totals for summer, autumn and winter 2012 in eastern Scotland were 161%, 89% and 82% respectively of the annual average rainfall levels for the period 1981-2010. This should be taken into consideration when reviewing the results as it could result in bias when compared with years where average rainfall levels were recorded. The higher rainfall will directly influence runoff, dilution and catchment water levels/throughput which have not been assessed.

- Due to limitations in the mapping data used to compile the Flood Estimation Handbook (FEH) catchment boundary, the area defined in the Annex 1 maps does not necessary present an accurate reflection of the hydrological catchment for the site. Whilst this affords a valuable tool for the purposes of this study, the mapped boundary should be viewed as an indicative guide only and be subjected to detailed verification to be considered definitive.

4. ANALYTICAL DATA

The following tables show the results obtained from the initial site visit (Visit 1) in which samples from the pre-determined locations (or as close to as practically possible) were collected. Where the pre-determined locations were not accessible comparable alternative locations with the same habitat features were sampled.

Table figures in red indicate relative atypical (*e.g.* high or low values) or anomalous results or observations relative to the collected dataset or which would typically be expected from a site of this nature. These are discussed further in section 6.2.

4.1 Water Quality Field Data

The following data was collected by a suitably qualified operative using the methods outlined in section 2.

Table 4.1: Water Quality Field Data and Observations

Sample ID	Nat. Grid Reference		Temp (°C)	pH	Salinity (psu)	DO (%)	DO (ppm)	ORP (mV)	EC (mS/cm)	Comments
CL01	NT 55804	27302	7.99	7.61	0.35	17.9	2.48	-28	0.728	Groundwater - dark cloudy brown with fine s/s; no odour
CL02	NT 56057	27248	8.44	7.47	0.37	20.8	2.56	40	0.751	Groundwater - cloudy brown, some fine brown s/s; no odour
CL03	NT 55903	27219	8.10	7.27	0.34	12.7	1.50	32	0.726	Groundwater - cloudy brown, some fine brown s/s; no odour
CL04	NT 55859	27183	8.26	7.49	0.29	46.4	5.36	113	0.612	Surface water - very slow flow, clear with some pond weed on surface and a few very minor s/s; no odour
CL05	NT 55760	27190	8.43	7.37	0.39	28.4	3.34	126	0.801	Groundwater - light cloudy brown, fine brown s/s; very mild organic (sulphur) odour
CL06	NT 55637	27105	8.21	7.77	0.37	56.2	6.16	125	0.756	Surface water - clear with only a few very minor s/s; no odour; slow flow

4.2 Laboratory Results

The data in the following tables was collected by a suitably qualified operative using the methods outlined in section 2.

Table 4.2: Water Samples – Laboratory Analysis

Sample ID	Nat. Grid Reference		Sample Type+	Total Ca (mg/l)	Total Mg (mg/l)	Total Na (mg/l)	Total Fe (mg/l)	Amm N (mg/l)	Nitrate as N (mg/l)	Phosphate as P (mg/l)	Total P (mg/l)	Total N as N (mg/l)
CL01	NT 55804	27302	GW	123	11	10	3.38	0.70	<0.2	0.07	0.3	3
CL02	NT 56057	27248	GW	122	16	10	2.08	1.50	<0.2	0.03	0.3	3
CL03	NT 55903	27219	GW	111	16	8	16.5	0.24	<0.2	0.02	0.6	<1
CL04	NT 55859	27183	SW (OW)	81	12	9	<0.01	0.03	<0.2	0.01	<0.1	<1
CL05	NT 55760	27190	GW	119	15	9	0.12	0.12	0.4	<0.01	<0.1	<1
CL06	NT 55637	27105	SW (OW)	125	13	12	1.33	0.60	0.5	0.09	0.4	3

+ Surface water samples are designated either inflow (I), outflow (O) or open water (OW)
Red text denotes samples that exceed typical ranges

Table 4.3: Soil Samples – Laboratory Analysis

Sample ID	Nat. Grid Reference		Soil Type*	Extractable N (mg/Kg)	Total Ca (mg/Kg)	Total Mg (mg/Kg)	Total P (mg/Kg)	Total K (mg/Kg)	Tot Moisture ** 105°C (%)	Total N (mg/ Kg)	Nitrate (mg/l)	Nitrogen (%)	Extractable P (mg/l)
CL01A	NT 55804	27302	Brown earth	2.5	30100	8650	855	2010	70.8	2.9	0.4	1.53	4.95
CL01B	NT 55804	27302	Brown earth with some gravels	1.7	9220	13800	874	3140	54.6	1.9	0.2	0.87	<2.0
CL02A	NT 56057	27248	Brown earth	1.3	13300	10500	751	1830	65.1	2.1	0.8	0.89	3.05
CL02B	NT 56057	27248	Brown earth with some gravels	2.2	10200	11400	749	2030	60.2	2.5	0.3	0.67	2.6
CL03A	NT 55903	27219	Brown earth	0.6	29500	8530	839	2060	75.4	<0.8	<0.2	1.24	<2.0
CL03B	NT 55903	27219	Brown earth with some gravels	0.8	19000	7380	563	1340	67.5	<1.0	<0.2	0.81	2.6
CL05A	NT 55760	27190	Organic rich dark wet sludge	0.5	20400	1520	674	976	85.7	<0.7	<0.2	2.17	2.94
CL05B	NT 55760	27190	Organic rich dark wet sludge	0.6	62800	2310	573	831	83.5	<0.8	<0.2	2.29	<2.0

** Soil types are field observations*
*** Total Moisture = Water content*
*A/B suffix: **A** = Rooting Zone and **B** = Below Root Zone*
Red text denotes samples that exceed typical ranges

5. SITE OBSERVATIONS

To enhance the understanding of Clarilaw Grasslands and the surrounding area, preliminary research was undertaken and complemented with a second site walkover to further understand the landforms, drainage configurations, potential environmental sensitivities and possible diffuse pollution sources influencing the site.

5.1 Desk Study

The Site Management Statement (SNH, 2011c) records an 'Objective for management' of enhancing the conditions of the site by maintaining stock levels and grazing periods to produce a sward structure of varying heights that provide ideal conditions for plants and invertebrates. This is coupled with maintaining the basin fen to benefit the aquatic beetle interests. It is further stated that scrub, thistles and woody species need to be managed to prevent them from encroaching into the areas of calcareous grassland.

Site condition monitoring undertaken at the site concluded the following (SNH, 2011c):

- The lowland calcareous grassland was in unfavourable recovering condition when visited in 2009 due to encroachment of hawthorn and gorse scrub, presence of agricultural plant species, and over-grazing.
- The basin fen was in unfavourable declining condition when visited in 2003 due to the presence of scrub and invasive grasses, and lower than normal coverage of bottle sedge, a key indicator species.
- The beetle assemblage was in unfavourable declining condition when visited in 2003 due to the decline in condition of the mire habitats which support the beetle assemblage.

Other pressures identified at the site are dunging, concentrated on some of the knowes, and presence of rabbits contributing to the grazing pressures. A previous management agreement for the site included control measures such as scrub clearance, control of regrowth and weed control. A current Scotland Rural Development Programme (SRDP) contract is in place at the site to control scrub growth on the fen and grazing/nutrient input within the buffer area (SNH, n.d.).

Contrary to the SNH reports (SNH, 2011b and c), the desk study revealed that the site geology (for both east and west parts of the site) consists mostly of siltstone, sandstone and mudstone rather than limestone. The Site Management Statement indicates the presence of thin bands of limestone but this has not been confirmed by any of the information reviewed.

The desk study identified that historical soil samples had been taken in association with lime applications (Tabor, 1999) albeit that the records are not detailed in terms of location, depth *etc*. Given the limited information, confidence in such is very low and has been discounted for the purposes of this study.

5.2 Catchment Walkover

From the second site visit, post-receipt of the analytical results, the following observations of the surrounding catchment were made:

- The site was free of litter and no visible pollution sources were observed within the site boundary.

- Limited sightings of sheep and cattle were noted, however, evidence of dunging was observed across the site as a whole.

- No watercourses were observed on site and the areas of standing water were small and limited to the western end of the site. Some ponding of surface water was observed along the southern boundary and attributed to waterlogged soils.

- The drains observed in the eastern part of the site appeared to be localised and indicative of draining standing water in the western and southern part of the site.

- Evidence of the burning and/or treatment of Gorse (*Ulex europaeus*) was observed on site. This was predominantly on the slopes of the ridge above Blackchester Moss (in the vicinity of the trig point) and appeared to have been undertaken relatively recently.

- Evidence of fences, dunging and access routes within the site for horse trekking were observed. It was speculated that the site was possibly set up for use as a point to point course.

- Buffer strips are currently present with appropriate fencing. It is considered that this corresponds to the SNH management work as referenced in section 1.5.

- The most south western part of the site – in the vicinity of CL06 – was very wet and largely inaccessible without waders. Evidence of some efforts to drain this part of the site was observed.

- The FEH catchment boundary does not appear to align to the actual drainage of the site due to the southern boundary being in hydrological connectivity with the unnamed loch. Due to the difference in levels it is considered that only the flows from site input to the loch and not *vice versa*.

5.3 Summary

The following table provides a summary the key site features which were observed during the site visits or identified in the desk study undertaken as part of the study.

Table 5.1: Summary of key observations

Activities	Observations
Fencing	Entire boundary of site is fenced – although integrity of fencing not confirmed during scope of works.
Fishing	Not applicable - small and limited areas of open water.
Grazing	Site is grazed by both sheep and cattle (until 2012 this was monitored under an SNH Management Agreement).
Monitoring	Condition monitoring was carried out in 2003 (not reviewed) and 2009. Whilst soil sampling is known to have been undertaken no detailed records were viewed during the desk study. No previous water data is available.
Public Access	No formal access routes are present on the site although site is open and used by dog walkers and horse riders at the time of the visits.
Shooting	Used for occasional pheasant shoots. See Annex 2 for further details.
Point Pollution Sources	None observed within the SSSI boundary.
Properties in Catchment	Clarilaw Farm and Cavers Carre residential properties are sited within the SSSI catchment. Given the rural location it is suspected that these properties are most probably served by a septic tank.
Unusual, Distinctive or Atypical Features	Potential for storage of animal wastes within the immediate catchment; evidence of burning of Gorse; and evidence of horse trekking occurring within the site.

A mapped summary of the perceived catchment pressures is detailed in Figure 5.1 (see Annex 1).

6. INTERPRETATION OF RESULTS

The following assessment is based on the field tests and laboratory analytical results only.

6.1 General summary

The sample data indicates elevated nutrients within surface water, groundwater and soil samples obtained. Whilst there is no historical data to compare these results, the concentrations of inorganic nutrients recorded are typically at levels which are higher than would be expected for natural calcareous grassland and are likely to have resulted from changes in land management practices to improve the soil.

The groundwater quality at the site was deemed to comprise relatively high concentrations of bioavailable nutrients with elevated nitrogen present in the majority of the samples. With the exception of CL06 in which a comparable total nitrogen result was recorded, the results were lower in the open water samples. This is attributed to CL06 being located at the western end of the site and deemed to be the lowest and wettest part of the site. It is considered that this locations acts as a nutrient sink with surface runoff channelled to this point.

With the exception of iron concentrations in the groundwater samples, none of the analysed metals were recorded as being particularly elevated. The inorganic concentrations of bioavailable nutrients were typically higher in the groundwater samples when compared to the surface water samples however, as no obvious trends are evident, this may simply be explained by the limited number of surface water samples collected (see section 3).

With the exception of CL05, the groundwater samples were found to have an elevated iron concentration when compared to the surface waters. This aligns with the lower dissolved oxygen concentrations and marginally lower pH values which are likely to lead to the precipitation of iron in groundwater.

CL04 is sampled from standing water within the site. The recorded dissolved oxygen level of 1.5ppm is lower than expected and may be attributed to stagnation. This may be seasonal but may in turn pose a constraint to the health and proliferation of the notified water beetle community.

Inorganic nutrient levels in the soils samples were observed to be elevated and attributed to the historical intensive management of the site. Extractable phosphate levels were elevated in the upper (root zone) soil samples with the higher values generally aligning with the higher extractable nitrogen and total nitrogen values.

It should be noted that the limited spatial distribution (*i.e.* 'clumping') of the sample locations within the south western part of the site and no provision for the northern or eastern boundaries, does not aid the assessment as to whether these observations are localised or representative across the whole of the SSSI.

6.2 Atypical results

No consistent atypical or anomalous results were recorded from the soil or water samples at Clarilaw Grasslands. From the limited dataset presented in section 4, the highlighted figures are those observations of note and are individually detailed below:

- Although lower than the only comparable sample, the low dissolved oxygen result in CL03 is not considered atypical as it from a groundwater source. This could indicate pollution of the groundwater source exerting 'an oxygen demand' at this location however, this is not supported by the other analytical results for this location.

- Calcium levels in all soil samples were elevated. Given that the site comprises calcareous grassland which require high levels of calcium to support the plant species identified, and there has been a history of lime (calcium carbonate) application to the soil, these results are not deemed atypical although as a result, they may constitute an artificially high value over that which would otherwise naturally occur.

- Soil sample CL01A has an increased level of extractable phosphorus relative to all other sample locations. As the total phosphorus, extractable nitrogen and nitrate values are also elevated, it is considered that this may be attributable to the addition of artificial fertilisers or animal wastes.

- There are elevated levels of nitrogen across the site. The elevated ammoniacal nitrogen in groundwater samples CL01 and CL02, with results of 0.7mg/l and 1.5mg/l respectively, are indicative of organic decomposition or nutrient enrichment from animal wastes.

6.3 Additional considerations

See study limitations presented in section 3.

Historical or future data to assess and evaluate the beetle assemblages may comprise water quality analyses which could be of value in understanding long-term trends and changes within the site.

7. CONCLUSIONS

Despite the limitations outlined in section 3, the analytical results highlight elevated nutrients in the soil, surface and groundwater samples, across the visited site. No observations or conclusions are made on the western site which was out with this study,

From the desk study and site walkovers, the elevated nutrients are supported by observations that indicate there to have been changes in land use management in the immediate catchment namely the application of soil conditioners and plant control measures. As the SSSI is used for the grazing of cattle and sheep, there is the potential for adverse effects on the natural vegetation through overgrazing (particularly in winter) and the associated effects of dunging and trampling. This is heightened when combined with the intensive management approach of re-seeding of low productivity areas and changing the soil composition through fertiliser and lime applications.

Over the course of many thousands of years the site will have changed with the western and southern aspects in particular functioning as a sink for the surrounding landform. It is likely that the site initially comprised a lake which over time has been infilled by organic material. This in turn created a rich substrate in which other plants could prosper and the further infilling and successional change that is presently observed. This process will be compounded at present by the nutrient inputs within the site boundary. Due to the undulating topography, it is expected that the site will be heavily influenced by the quality and quantity of water which flows to the site. These flows which will vary seasonally, will leach nutrients from the surrounding catchment and due to the levelling out of the landform and poor drainage will accumulate within the site. There are significant benefits to be gained from understanding the drainage configuration of the site and where man-made alternations to the natural systems have been introduced.

Evidence of agricultural improvements to the immediate catchment and the contribution from the groundwater are expected to aid migration of nutrients across the site. The nutrient transfer may be further heightened by the anthropogenic changes to the natural site drainage. There will be some runoff, albeit minimal in comparison, from the access track which passes to the west of the site. This track is expected to be used by farm and 4x4 vehicles which will have a heightened impact and cause rutting in wet weather conditions leading to the infilling of the site drains and inhibiting throughput. Evidence of horse trekking was observed on the site, which could also have an impact on soils through compaction and erosion and lead to some nutrient input.

Changes in nutrient concentrations within the mire are expected to have a direct effect on the water beetle community. These may be determined through a review of the relative pollution tolerances of the community species known to be present and compared with those now extinct or of significantly reduced population.

Herbicide applications are known to have taken place to control agricultural weeds. Depending on the methods and substances used, uncontrolled applications may be windblown to areas not otherwise intended for treatment and/or contaminate groundwaters and subsequently impact on other parts of the site.

Clarilaw Farm and Cavers Carre properties are located within the catchment and in close proximity (*c.*200m and *c.*300m respectively) of the site boundary. Given the remote location of the site it is expected that these dwellings will be served by septic tanks and hence the foul water flows could drain into the site. Further research and sample data within the fields out with the site boundary, or at the boundary itself, would be needed to corroborate this.

8. RECOMMENDATIONS

Based on the understanding gained from the sampling exercise and catchment visits, the following recommendations are proposed:

8.1 Monitoring

i. Undertake a long-term targeted monitoring study at selected locations within the site for key nutrients – to include orthophosphate and bioavailable (extractable) nitrogen. Ideally this would be undertaken over the course of several seasons (ideally for a minimum of one year). The data from such should be compared alongside rainfall data and seasonal abnormalities to seek to understand the nutrient dynamics taking place within the site.

8.2 Other commissioned studies

ii. Undertake hydrological and hydrogeological assessment of the contributing catchment in order to determine the quality and quantity of the source flows. This should include the linkage with and characteristics of the unnamed waterbody which lies along much of the southern boundary of the site. Given the standing water within the site it would be of value in undertaking a further site walkover during a period of low rainfall (but not drought conditions) to see whether groundwater derived flows are evident on site.

iii. In conjunction with ii, review the extent of, and changes to, the standing water within the site. If routinely monitored, this information will further aid the understanding of the site and may be used to correlate the observed changes in flora composition.

iv. Undertake a topographical survey of the site to understand the surface water flow regime and how field drains influence the swamp and mire areas.

v. Review the historical beetle assemblage data using one of the known macroinvertebrate intolerance to pollution indices. Unlike 'spot' monitoring, the beetles are present all the time and so provide a consistent indicator of the prevailing environmental conditions. Given that over 18 water beetle species have been identified at the site, it is expected that through using the variations in the community composition and population numbers, and known variations to pollution tolerance between genus/species, it may be possible to gain a further insight into the likely changes to the site, and particularly water quality, over time.

vi. Undertake a detailed library review, including historical mapping and local data sources, to seek to understand historical land use and information relating to the former SSSI site and contributing catchment.

8.3 Landowner/ Tenants

vii. Proactively engage with local landowners to understand the management practices which are undertaken within the SSSI boundary. It is understood from the latest SNH Site Management Statement (SNH, 2011c) that the management agreements expired in 2012 but that a new SRDP contract is in place (SNH, n.d.).

This process should include an assessment of the storage and disposal of animal waste employed within the catchment; burning of vegetation (Gorse) activities which take place across the site; horse trekking activities; and an understanding of the existing and (foreseeable) proposed changes to the immediate catchment including field use, crop type and soil conditioning approaches. Consider appropriate

management strategies accordingly - for example (but not exclusive to) nutrient management planning, exclusion zones, buffer strips, fencing of sensitive areas, routine spot monitoring *etc*.

viii. Engage with landowners to ensure septic tanks in the site catchment are well maintained and do not lead to nutrient inputs.

ix. Review the use of known herbicides on site and the timings, methods and reasons for their application. Consideration to be made to employing alternatives and where required, including controls in any future management agreement along with a requirement for the landowner to notify SNH in advance of any applications being made.

x. Review the use of lime applications at site and the timings, methods and reasons for their application.

From the stated conclusions and identified pressures (Figure 5.1) the key actions to seek to reverse the present declining status of the site are to address the inputs to the site from the agricultural activities within the catchment namely the application of animal wastes and fertiliser (vii), herbicides (ix) and lime (x); the likely impact to site nutrients from the potential septic tanks (viii), and an understanding of the water balance/throughput and how this affects the size and extent of standing water across the site (ii).

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ANNEX 1: FIGURES

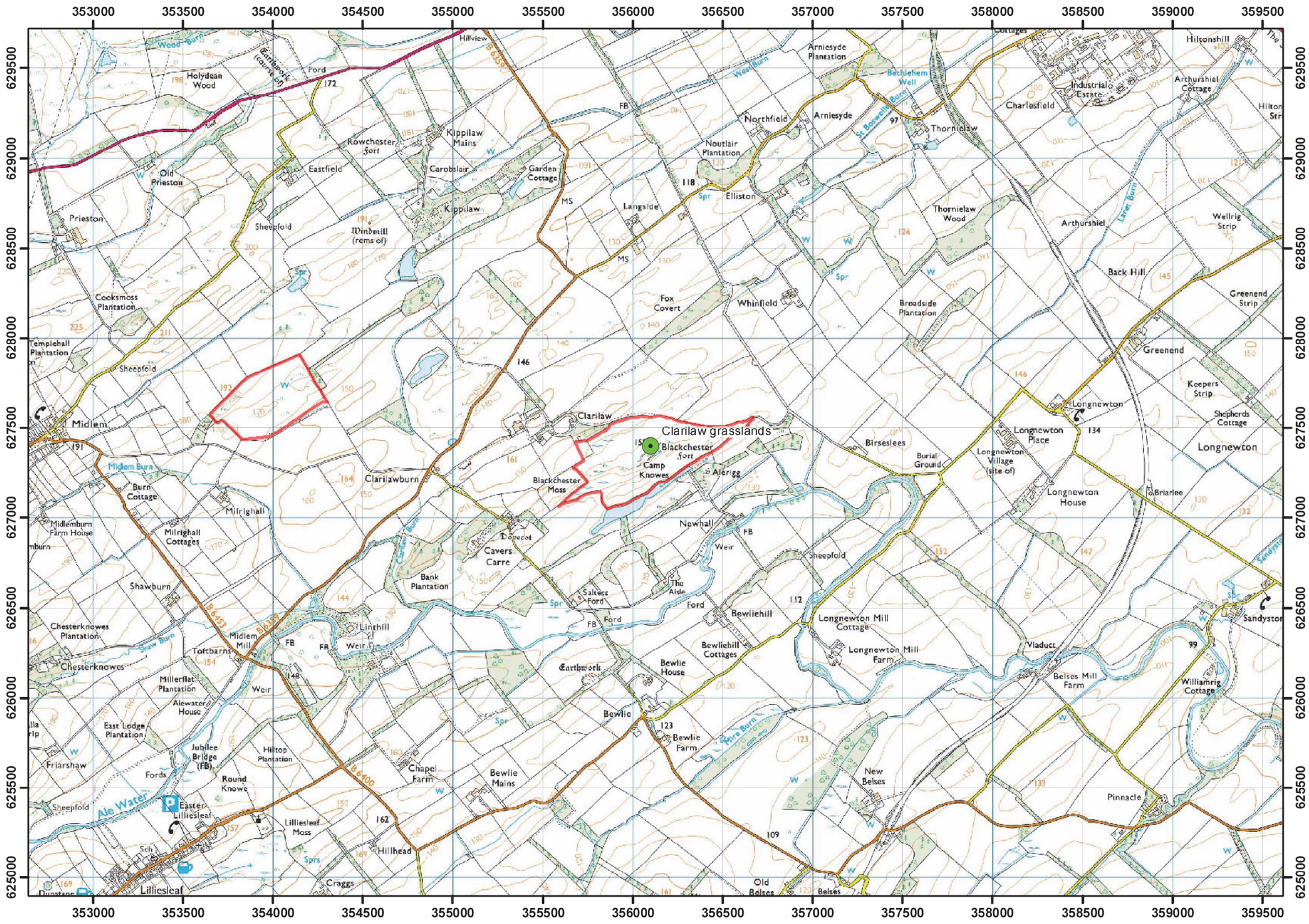
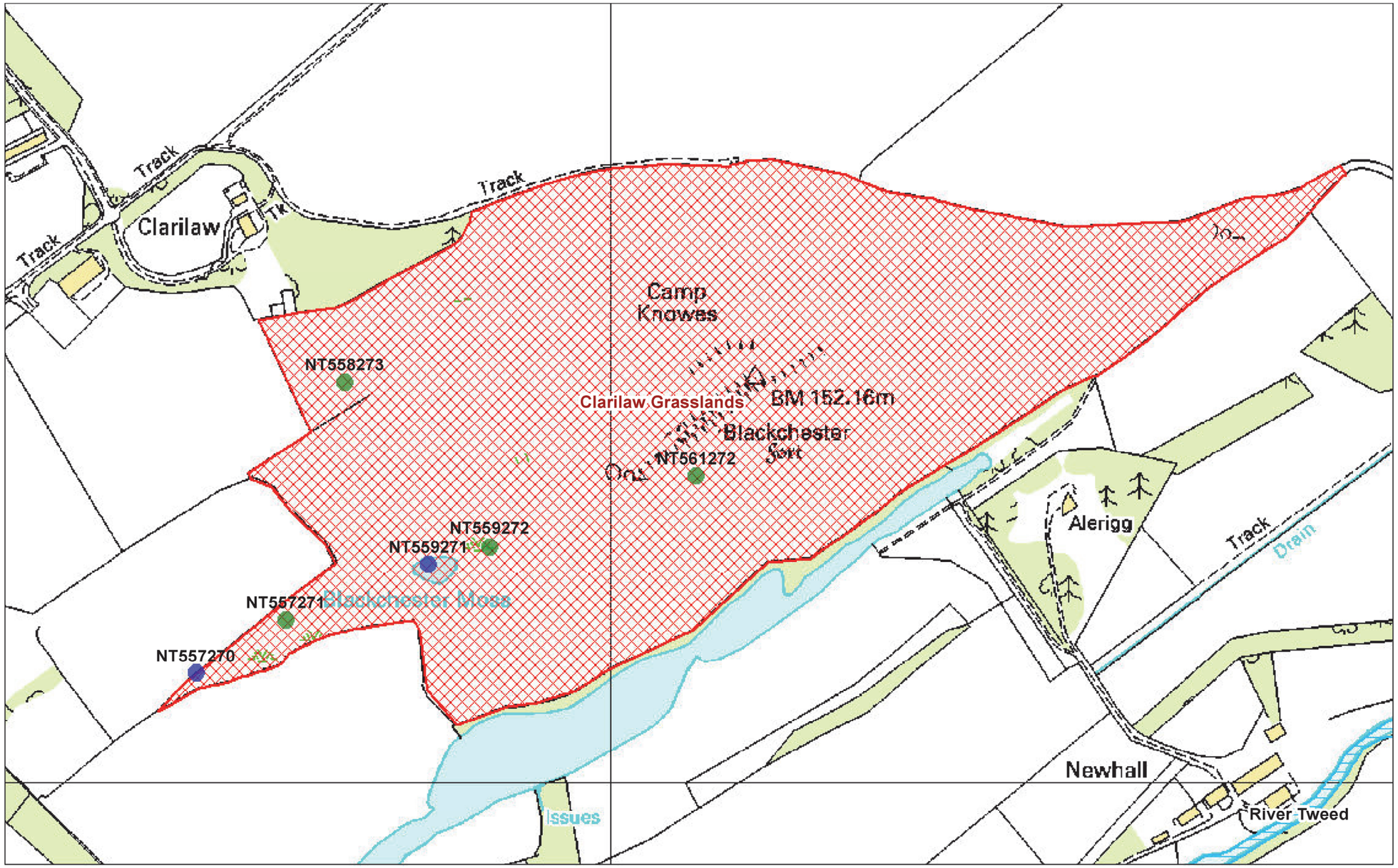


Figure 1.1: Site Location Map

Clarilaw



Notes:

Map produced using geo.View 3.0
Printed: Sep 20, 2012 15:15:20

Figure 2.1: SNH Proposed Sampling Location Plan

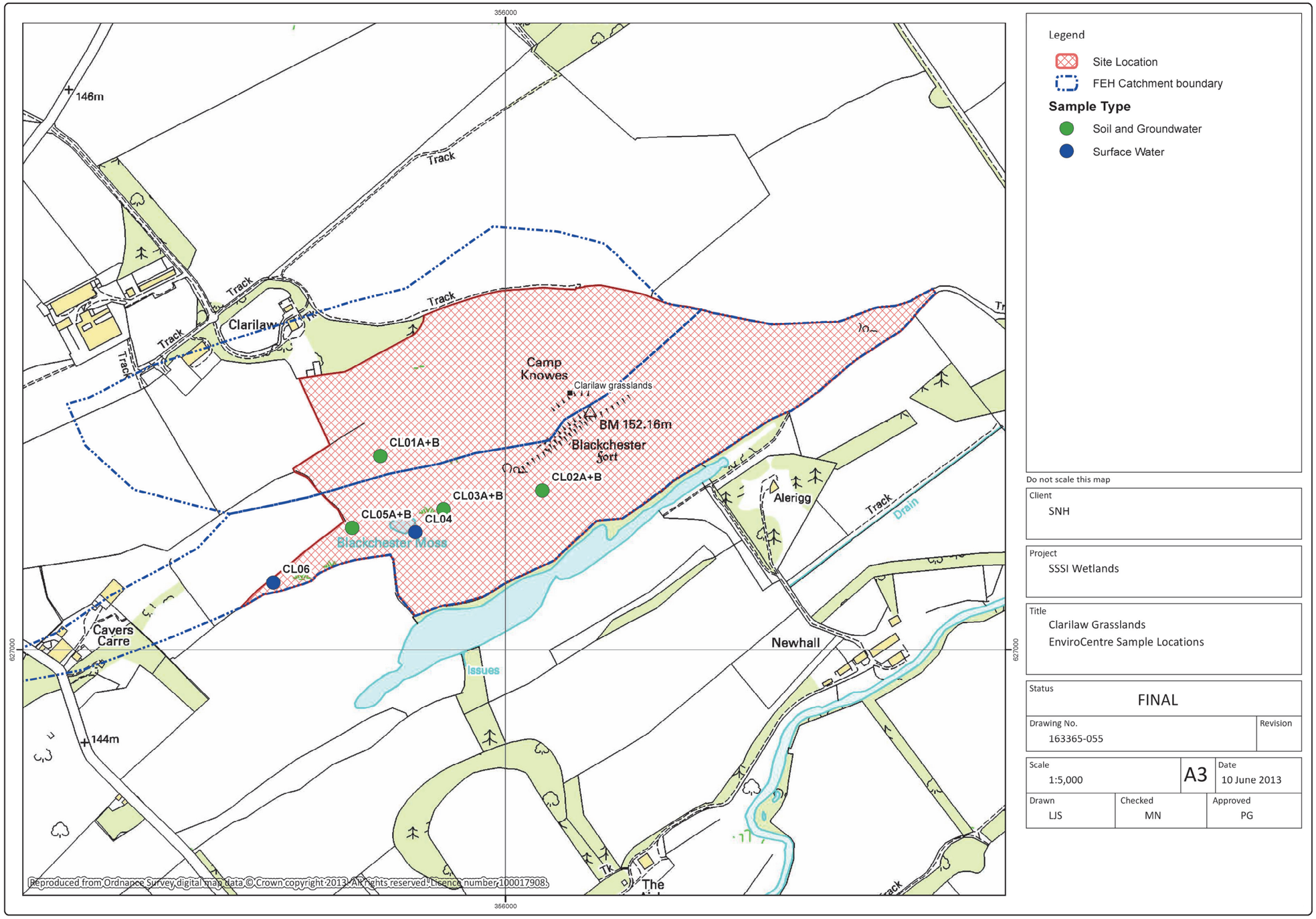


Figure 2.2: Plan of Actual Sampled Locations

Photograph Log - Sample Locations
(Photographs taken on 6th November 2012)

Figure 2.3: Photographs of Sampling Locations

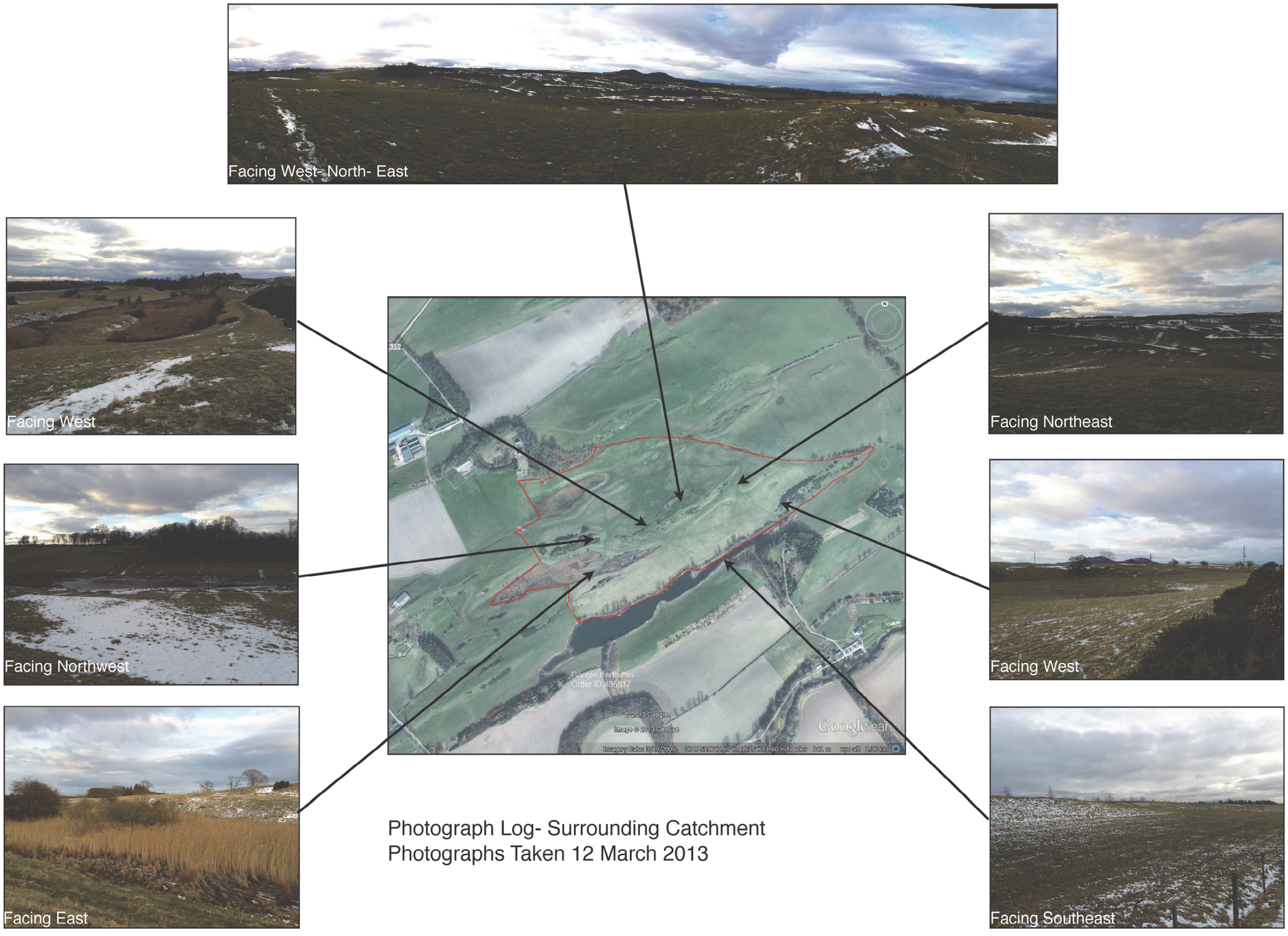


Figure 2.4: Surrounding Land Use Photographs

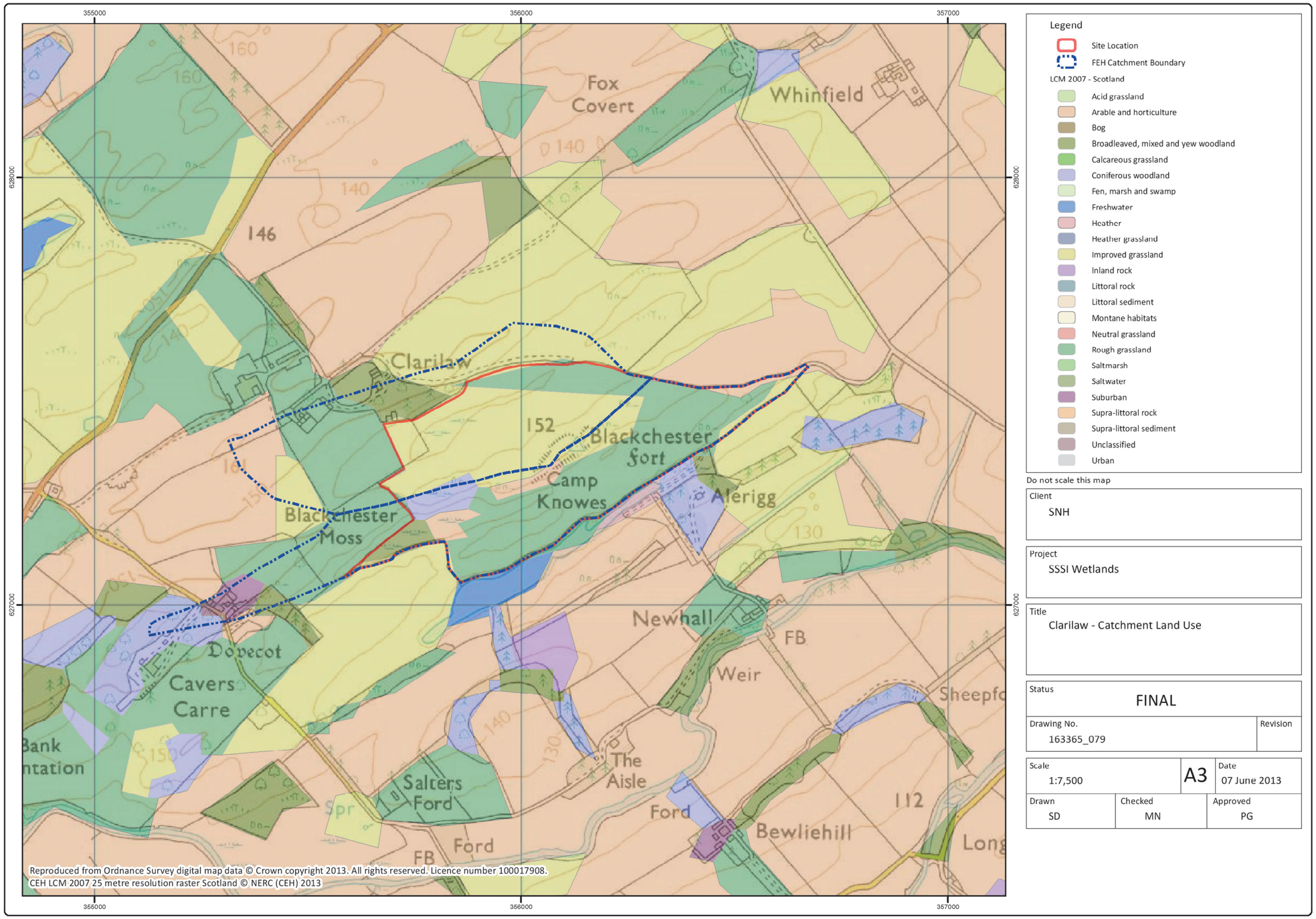


Figure 2.5: Catchment Land Use Characteristics

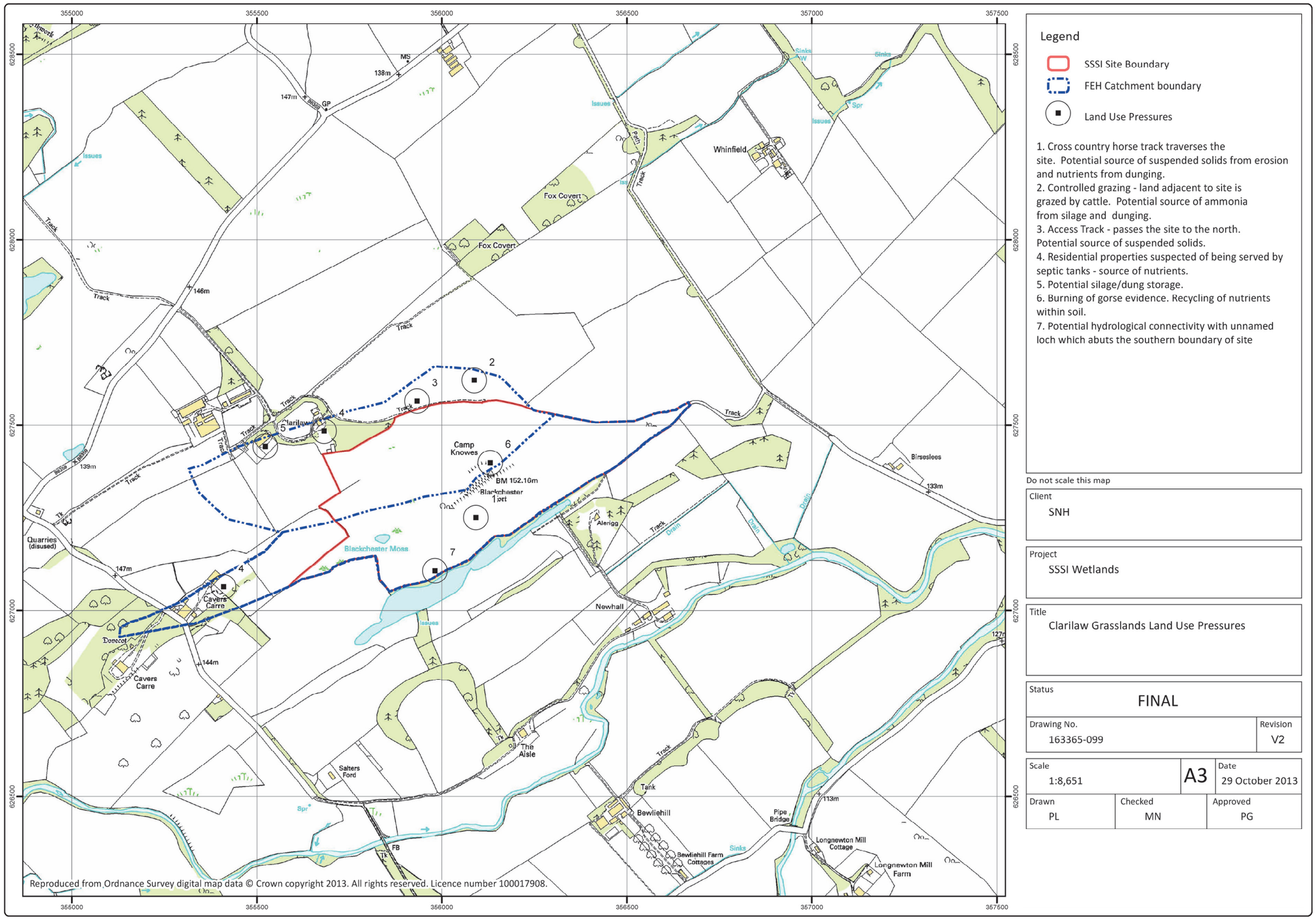


Figure 5.1: Catchment Pressures Land Use Summary

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